Hall Ticket No | | | | | | | | | | | Question Paper Code: AME013

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech V Semester End Examinations (Regular) - November, 2018

Regulation: IARE – R16

THERMAL ENGINEERING

Time: 3 Hours **(ME)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Explain with neat diagram the working of Rankine cycle and derive the expression for its efficiency. **[7M]**

   (b) Superheated steam at a pressure of 10 bar and 400^0C is supplied to a steam engine. Adiabatic expansion takes place to release point at 0.9 bar and it exhausts into a condenser at 0.3 bar. Neglecting condenser work, determine the following for a steam flow rate of 1.5 kg/s: (i) Quality of steam at the end of expansion and the end of constant volume process. (ii) Power developed. (iii) Specific steam consumption. (iv) Modified Rankine cycle efficiency. **[7M]**

2. (a) Explain with the help of diagram a regenerative cycle and derive the expression for its thermal efficiency **[7M]**

   (b) A simple Rankine cycle works between pressures 28 bar and 0.06 bar. The initial condition of steam being dry saturated, calculate the cycle efficiency, work ratio and specific steam consumption. **[7M]**

UNIT – II

3. (a) Explain the construction and working of a Lancashire boiler with the help of suitable sketch. **[7M]**

   (b) Dry saturated steam enters a nozzle at a pressure of 10 bar and with an initial velocity of 90 m/s. The outlet pressure is 6 bar and the outlet velocity is 435 m/s. The heat loss from the nozzle is 9 kJ/kg of steam flow. Calculate the dryness fraction and the area at the exit , if the area at the inlet is 1256 mm^2. **[7M]**

4. (a) Explain the construction and functions of economizer and air pre heater with neat sketch **[7M]**

   (b) Steam at a pressure of 15 bar and dryness fraction 0.97 is discharged through a convergent –divergent nozzle to a back pressure of 0.2 bar. The mass flow rate is 9kg/kWh. If the power developed is 220 kW, determine the throat pressure. **[7M]**

UNIT – III

5. (a) With the help of neat sketch explain a low level jet condenser of the parallel flow type. **[7M]**

   (b) In an impulse turbine , the mean diameter of the blades is 1.05 m and the speed is 3000 rpm. The nozzle angle is 18^0, the ratio of blade speed to steam speed is 0.42 and the ratio of the relative velocity at outlet from the blades to that at inlet is 0.84. The outlet angle of the blade is to be made 3^0 less than the inlet angle. The steam flow is 10 kg/s. Draw the velocity diagram for the blades and find : tangential thrust on the blades, axial thrust on the blades, power developed in the blades and blade efficiency. **[7M]**

6. (a) With a neat sketch explain the construction and principle of operation of a ejector condenser. **[7M]**

   (b) A single stage steam turbine is supplied with steam at 5 bar, 200^0C at the rate of 50 kg/min. It expands into a condenser at a pressure of 0.2 bar. The blade speed is 400 m/s. The nozzles are inclined at an angle of 20^0 to the plane of the wheel and the outlet blade angle is 30^0. Neglecting frictional losses, determine the power developed blade efficiency and stage efficiency. **[7M]**

UNIT – IV

7. (a) The air enters the compressor of an open cycle constant pressure gas turbine at a pressure of 1 bar and temperature of 20^0C. The pressure of the air after compression is 4 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air-fuel ratio used is 90:1. If flow rate of air is 3 kg/s, find: power developed, thermal efficiency of the cycle.
   Assume $C_p = 1000$ kJ/kgK, $\gamma = 1.4$ of air and gases. Calorific value of fuel= 41800 kJ/kg. **[7M]**

   (b) With the help of a neat sketch, explain the working of a closed cycle gas turbine. **[7M]**

8. (a) Explain the advantages and disadvantages of reciprocating compressors with rotary compressors. **[7M]**

   (b) A closed cycle regenerative gas turbine operating with air as the working medium. Assume the following data: p_1=1.4 bar, T_1=310K, p_2/p_1=5, T_{max}= 1050K, effectiveness of the regenerator is 100%, net output =3MW. Assuming the compression and expansion to be isentropic , calculate
   i) thermal efficiency
   ii) mass flow rate of air per minute **[7M]**

UNIT – V

9. (a) An aircraft engine operates at an altitude of 3000 metres above mean sea level and an aircraft speed of 525 kmph. The data for the engine is given below:

Inlet diffuser efficiency = 0.875

Compressor efficiency = 0.97

Velocity of air at compressor entry = 90 m/s

Temperature of air at compressor entry = 6.24^0C

Temperature rise through the compressor = 230^0C

Properties of air : $\gamma = 1.4$, $C_p = 1005$ J/kg K

Density of air = 0.909 kg/m^3

Calculate

(i) pressure ratio developed by the compressor

(ii) power required by the compressor per unit flow rate of air

(iii) the air- standard efficiency of the engine. **[7M]**

(b) Discuss in details the various propellants used in solid fuel rockets. **[7M]**

10. (a) Derive expressions for propulsive power, thermal efficiency, propulsive and overall efficiencies of turbojet engine. **[7M]**

(b) A turbojet engine consumes air at the rate of 60.2 kg/s when flying at a speed of 1000 kmph. Calculate

i) exit velocity of the jet when the enthalpy change for the nozzle is 230 kJ/kg and velocity co-efficient is 0.96

ii) fuel flow rate in kg/s when A/F ratio is 70:1

iii) thrust specific fuel consumption **[7M]**

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